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ABSTRACT

This paper describes research concerning the nature of basic skills prerequisite to the learning and performance of a single, technical job (31M10, Multichannel Communications Equipment Operator) in the Army, and development of an instructional program to teach the skills. The work involved six phases carried out over a 2-year period: (1) analysis of the 31M10 job and course to identify prerequisite skills, (2) verification of the identified skills, (3) design and development of a basic skills course to teach the verified skills, (4) construction and validation of a screening/diagnostic test to identify trainees deficient in the skills and to assign them to appropriate lessons, (5) development of instructional materials, and (6) validation of the basic skills course. One of the findings of the study was that the course developed could be used to teach basic skills, but that the skill retention rate was not as high as expected, possibly because of lack of opportunity for the trainees to practice the skills immediately following completion of the course. It was concluded that the procedures used in this project could be used to define and teach basic skills prerequisite to other technical jobs. (Procedures and results of each phase are discussed, and conclusions and recommendations are drawn for functional basic skills training in the military.) (Author/KC)

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DEVELOPMENT AND VALIDATION OF INDIVIDUALIZED INSTRUCTION IN FUNCTIONAL BASIC SKILLS FOR THE ARMY

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ABSTRACT

Development and Validation of Individualized Instruction
in Functional Basic Skills for the Army

This paper describes research concerning the nature of basic skills prerequisite to the learning and performance of a single, technical job (31M10, Multichannel Communications Equipment Operator) in the Army, and development of an instructional program to teach the skills. The work involved six phases carried out over a two-year period: (1) Analysis of the 31M10 job and course to identify prerequisite skills. (2) Verification of the identified skills, (3) Design and development of a basic skills course to teach the verified skills, (4) Construction and validation of a screening/diagnostic test to identify trainees deficient in the skills and to assign them to appropriate lessons, and (6) Validation of the basic skills course. Procedures and results of each phase are discussed, and conclusions and recommendations are drawn for functional basic skills training in the military.

INTRODUCTION

The Army has long been concerned with the low level of basic skills of some recruits. Soldiers who are unable to read their technical and field manuals, and who lack basic quantitative and writing skills cannot fulfill the requirements of their jobs in the field. As a result, the Army has become one of the major teachers of remedial basic skills. Basic Skills Education Programs (BSEP) are now offered, at several levels of proficiency, at Army posts throughout the country and abroad.

However, with the exception of a few experimental programs, BSEP training usually differs little from reading, writing, and arithmetic instruction in elementary school. The skills taught are general skills; the methods include materials developed for teaching the skills to children; and the goals are generally expressed in terms of reaching a certain grade level, rather than acquiring particular skills.

There are several problems with this approach to basic skills training. First, the specific basic skills needed for carrying out military jobs often differ from those taught in BSEP. For example, while traditional reading instruction stresses reading-to-learn (reading to store information); Army reading usually involves reading-to-do (reading to perform an immediate task). Second, the materials and methods do not appeal to adults, especially adults who have been "turned off" by traditional instruction for some time. Third, the time allotted (usually a maximum of six weeks), is too short to raise general literacy skills to a level sufficient to deal with military materials; Army TMs, for example, are frequently written at the 11th grade level or above.

There is evidence that, when reading instruction is more closely related to the jobs soldiers will perform, reading level on job materials can be raised by a significant amount in a relatively short time. For example, Thomas Sticht and his associates (Sticht, 1975) developed a program of Army Functional Literacy Training (FLIT) which used materials related to clusters of Military Occupational Specialties (MOS) to teach job-related reading skills. The skills included: using tables of contents and indexes, reading tables and graphs, reading technical manuals (TM) for factual content and procedural directions, and reading to get information necessary to complete data forms. Job-related reading skills of students increased an average of 2.1 grade levels in the six-week training program, and most of the gain was retained for at least seven weeks.

In 1981, Applied Science Associates (ASA) contracted with the Army to develop a Functional Basic Skills Education Program (FBSEP) for teaching skills and learning strategies* prerequisite to successful performance in advanced training (AIT) for one Army MOS, selected because of a

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* In the rest of this paper, the term "skills" will usually refer to both skills and strategies, as well as competencies and knowledges, prerequisite to AIT success.

relatively high academic failure rate during AIT training. The contract required that ASA analyze the AIT course to identify prerequisite skills, empirically verify the skills, develop and validate a screening test to identify trainees requiring FBSEP instruction, and design, develop, and validate the needed instruction. The FBSEP course was to be individualized and self-paced, so that each student would receive instruction in all those skills, and only those skills, in which he/she was deficient; in addition, FBSEP instruction was to be integrated with AIT instruction as much as possible (as opposed to frontloaded), so that basic skills could be taught just prior to the point where they were needed in the AIT course. It was hoped that the procedures and results of FBSEP development for one MOS could be generalized to other MOSs or clusters of MOSs. Concurrent with this effort, the U.S. Army Training and Doctrine Command (TRADOC) contracted for the Baseline Skills Analysis of 94 MOSs. In addition, a contract was awarded for a third party evaluation (Shepherd, 1983).

The MOS which was selected, the 31M10 of the Signal Corps, involves installing and operating both low capacity and medium capacity radio and cable equipment, as well as auxiliary equipment (antennas and generators) in field settings. The job also requires a certain amount of equipment troubleshooting and maintenance, primarily preventive; any repairs which necessitate getting "inside" the equipment or using specialized tools are referred to a higher level of maintenance.

The AIT course which qualifies students for this MOS is partly classroom-based, where students listen to lecture/demonstrations about equipment operation, and partly field-based, where students practice operation in a realistic field setting. The course is eleven weeks long. Requirements for selection for the course include normal color perception and an EL score of 100 or more. On the Armed Forces Qualification Test, the majority of students fall in the lower half of Category III, the rest in Category IV. The development of FBSEP for the 31M10 MOS involved six distinct phases:

Phase 1. Analysis of the 31M10 AIT course to identify prerequisite skills.

Phase 2. Verification of the skills identified in Phase 1.

Phase 3. Design and development of the FBSEP course based on the organization of verified skills into units and lessons within units.

Phase 4. Construction and validation of a Screening-Diagnostic Test to measure the skills, in order to identify soldiers who require FBSEP instruction.

Phase 5. Development of instructional materials.

Phase 6. Validation. This stage involved large-scale tryout of all the instructional materials and collection of data for evaluating their success.

The six phases are described in the sections which follow.

ANALYSIS OF THE 31M10 COURSE TO IDENTIFY PREREQUISITE SKILLS

In order to identify those competencies which are prerequisite to success in the 31M10 AIT course, course materials and the course delivery system were examined and analyzed. Materials include a "Soldier's Manual" which provides job descriptions of most MOS tasks, a variety of technical manuals (TMs) concerning operation and maintenance of equipment, and materials (e.g., handouts) developed by the course instructors. The delivery system was examined by analyzing lesson plans, interviewing course instructors concerning the content and delivery of lessons, and attending a sample of the course lessons from each part of the training sequence.

A Gagne-type procedure (Gagne, 1977) was used to identify prerequisite skills. For example, while examining a troubleshooting chart in a TM, in which a particular operation on equipment is described, the analyst would ask himself: (a) "What skills must a soldier possess in order to perform this operation?" and (b) "What skills must a soldier possess in order to comprehend the TM instructions for this operation?" For each identified skill X, the analyst asked, "Is X taught in the 31M10 AIT course?" If the answer was no, then X was defined as a prerequisite to successful performance in the course. Next, the process was continued iteratively. That is, for each X, the analyst asked, "What skills are necessary to do X?" resulting in the identification of hierarchically lower skills, Y, Z, etc. the process was continued until a level was reached at which it could be assumed that all normal adults possess the skill in question, e.g., counting in a hierarchy of quantitative skills. Thus, the analysis yielded sets of hierarchically interrelated skills in each of the following areas:

1. Learning outcomes related to working with equipment (associations, motor chains and procedures, perceptual discriminations and classifications, rule-using or reasoning).

2. "Traditional" basic skills, specifically defined in relation to 31M10 and AIT requirements. These included:

   a. Writing skills (filling out forms, verbatim copying, note-taking in lectures).

   b. Reading skills (knowledge of words commonly used in AIT materials; decoding skills; comprehension of procedural directions; interpretation of tables, charts, and cabling diagrams; skills needed for locating information in Army printed materials).

   c. Quantitative skills needed for reading meters on equipment (place-value, odd vs. even numbers, adding two two-digit numbers).

   d. Auding (listening/watching) skills needed for learning from lectures and demonstrations.

3. Technical information - factual knowledge of basic electronics.

4. Cognitive (learning) strategies, including:

   a. Focusing attention during lectures and demonstrations.

   b. Encoding information about equipment operation for memory storage.

   c. Strategies for retrieval of information from internal (memory) and external sources.

   d. Control processes for regulating learning and study behaviors.

The rational identification process described above yielded several hundred hierarchically interrelated skills. The next phase of development work involved empirical verification of the identified skills.

VERIFICATION OF PREREQUISITES

Empirical verification of identified prerequisites was conducted in order to answer the following questions: (1) To what degree do two or more analysts, working independently, reliably identify the same prerequisites with the same hierarchical ordering for a given AIT task or behavior? (2) For each identified prerequisite, is there a relationship between the skill and AIT course performance? (3) Are the hypothesized hierarchical relationships among the skills correct? Because of the large number of skills to be verified, verification was conducted in three stages.

Verification: Stage I

The first stage of verification was conducted to answer the first question above. Five analysts independently identified prerequisites for one fairly complex task with which students frequently had difficulty in the AIT course, using the analysis procedures described in the previous section. For each pair of analysts, the identified skills were classified as "matches" (Identified and categorized in the same taxonomic category by both analysts) and "mismatches" (either identified by only one analyst or placed in different categories by the two analysts). A percentage of agreement index was then computed as follows:

$$\text{Percentage of agreement} = \frac{\text{Number of matches}}{\text{Number of matches + number of mismatches}} \times 100$$

The percentage of agreement for pairs of analysts ranged from 68% to 87%, with an average of 75%. Since the criterion for a match was quite stringent, we concluded that the analysts could reliably identify prerequisite skills.

To verify the reliability hierarchical ordering of skills, a rank-order correlation coefficients was computed for each hierarchy and pair of analysts. Coefficients ranged from .86 to .94, resulting in the conclusion that hierarchies, as well as the skills within them, were reliably identified using the rational analysis procedures described.

Verification: Stage II

The reasoning behind the second question ("For each prerequisite, is there a relationship between the skill and AIT course performance?") was that, if a given skill is truly prerequisite to success in the AIT course then students who possess that skill are more likely to do well in the course than students who lack the skill. In order to answer this question, the performance of good and poor students on each skill must be compared. Given the large number of skills (comparisons) and practical

limitations on the amount of time available for testing students (the Army had set a limit of 2-3 hours), we set out first to verify those skills which fell at the lowest levels of their respective hierarchies, reasoning that many of these would be found to be possessed by poor as well as good students and thus could be eliminated from further consideration. These skills included decoding and interpreting simple procedural directions in reading; identification of odd and even numbers, adding single digits and two-digit numbers in arithmetic; simple motor procedures and perceptual discriminations; as well as others. Thus, the major purpose of the second stage of verification was to define the lowest level of skills which needed to be taught in the FBSEP course.

Two additional classes of skills were selected for verification at this stage: (1) technical information and (2) learning strategies. Technical information was selected because discussions with AIT instructors had suggested that such information was not necessary to doing well in the course, making this entire category of skills a candidate for elimination. Writing skills and learning strategies were selected because, as less extensively studied basic skills, they were less clearly delineated than skills in other categories, and also because the testing procedure devised for Stage II verification (clinical interview) lent itself to obtaining information about them.

A clinical interview format was used to obtain information from a sample of 27 students identified by AIT instructors as "good" and 35 identified as "poor" based on their most recent AIT test performances. The interviews were individually administered and included test-like oral exercises, written questions, exercises measuring technical information and writing skills, and open-ended questions concerning learning styles and study techniques. The results of this stage of verification are summarized below:

1. Many "tests" of low-level skills, e.g., associations, motor chains, discriminations, reading exercises involving decoding (sounding out) words, presented no problem for either good or poor students, resulting in the decision to eliminate them from the set of prerequisites to be taught. However, some relatively low-level skills, e.g., interpreting simple procedural directions in TMs, were more difficult for poor than good students and were retained.

2. No differences were found between good and poor students in a brief quiz covering technical knowledge of basic electronic facts and principles. As a result, technical information concerning electronics was eliminated from the set of prerequisites to be taught.

3. With respect to writing skills, all the students, good and poor, were able to copy verbatim material that was displayed or given orally. However, in note-taking for a brief "lecture" administered by the interviewer, marked differences were found.

The notes of good students included both more information and a higher degree of hierarchical structure (organization of material under headings and subheadings, clear relationships among parts of the lecture). Hence, verbatim copying was eliminated from the list of prerequisites to be taught. Note-taking was not only retained but also identified as potentially of major importance.

4. The data suggested some possible relationships between learning strategies and study skills and success in AIT training. For example, good students were somewhat more likely to report the use of visual imagery for encoding and retrieving information about equipment, and good students were more likely to refer to printed materials when they needed information. However, the differences were regarded as tentative and subject to further verification.

Verification: Stage III

The purpose of the third stage of verification was to determine the relationship between AIT performance and each identified prerequisite skill which had not been eliminated in the previous stage. In addition, The data were also used to verify the hypothesized hierarchical relationships among the skills. In addition, Stage III verification provided an opportunity to try out test items from which the screening-diagnostic test was to be constructed (Phase 4 of FBSEP development).

The last stage of verification involved construction of a test measuring the identified skills and administration of the test to a large sample of students in the AIT course. For each skill other than learning strategies, six multiple-choice items were written. Care was taken to match each item to the specific skill, to keep reading level simple (except in items measuring reading skills), and to use content from AIT materials. For measuring listening and note-taking skills, audiotapes and videotapes were made of lectures and demonstrations similar to those delivered in the AIT course, and comprehension items were written based on the information presented in the tapes. Listening items were designed to be answered by students immediately after hearing/viewing a tape, without benefit of notes; to measure note-taking skills, students took notes during a tape, then used the notes to answer questions encountered considerably later in the test.

Items to measure learning strategy use were of a different form. Each item described a particular strategy (e.g., forming a mental image of equipment operation while watching a demonstration) and asked the examinee to select one of four alternatives of the following types:

a. This is what I do most of all.

b. I do this a lot, but not most of all.

c. I do this a little, but not a lot.

d. I do not do this at all.

After the items had been written and assembled, it was clear that test administration would require well over the three hours allotted by the Army. therefore, the test was split into two non-parallel halves, each measuring approximately half the skills.

The test was administered in four successive weeks to students just beginning the AIT course (Week 1 students), students just graduating from the AIT course (Week 11 students), and students in Weeks 2-10 who had failed a course test during the previous week. Beginning students were needed because they were representative of the students for whom the FBSEP was being designed. However, course performance data essential for verification obviously were not available for this group. Graduating students were tested because their AIT performance data were already available and to provide comparisons with beginning students. However, Week 11 students were all, by definition, successful in the AIT course; therefore, students failing in Weeks 2-10 were tested in order to provide a group of potentially unsuccessful students for whom some course performance data were available. The table below shows the number of students tested.

Table 1. Number of Students Tested

	Beginning Students	Graduating Students	Failing Students
Test of One Half of the Skills	95	41	10
Test of the Other Half of the Skills	68	52	3

Because of their small number, the failing students were dropped from the analysis. The tests of the remaining students were scored by assembling skills (each of which was measured by only six items) into clusters of hierarchically interrelated skills. For example, all eight skills identified as contributing to comprehension of sentences giving procedural directions, yielded a single score for "sentence comprehension" based on 48 items.

Analysis of Relationship of Skills to AIT Performance

Skills Other Than Learning Strategies

The analysis procedures and results are discussed in two parts: (1) Relationship between skill clusters and AIT performance in graduating students, and (2) Comparison between beginning and graduating students.

Relationship between skill clusters and AIT performance in graduating students. Two measures of AIT performance were computed for each graduating student: (1) the sum of scores on five written and performance tests administered during the course (TESTSUM), and (2) the sum of performance scores on five tasks which constituted the end-of-course test (EOC SUM). In addition, the graduating students were divided into the following three groups, based on a combination of both measures:

I. Highly successful students. These were students who, during the course, had not failed any tests, either written/performance tests or EOC test tasks.

II. Moderately successful students. These were students who either failed one or more written/performance tests or one or more EOC test tasks, but not both.

III. Marginal students. These were students who, during the course, failed at least one written/performance test and also failed at least one task in the EOC test.

The following indices of relationship between prerequisite skills and course performance were computed for all skills except learning strategies:

1. Correlation (r) between each skill cluster and TESTSUM.

2. Correlation (r) between each skill cluster and EOC SUM.

3. Analysis of variance of the difference among the means of the three criterion groups (Highly successful, Moderately successful, Marginal) on each skill cluster

Table 2 lists the skill clusters which met at least one of the following criteria: (1) significant correlation ($p < .05$) with TESTSUM or EOC SUM; (2) significant difference between criterion groups. For convenience in reading the table, the clusters are listed in outline form, under relevant headings and subheadings.

Comparison of beginning and graduating students. Despite the fact that data from graduating students were needed for verification of prerequisites, the FBSEP course under development was intended for use with beginning students. Therefore, it was important to compare the two groups in order to determine the degree to which the results of the previous analyses were likely to be generalizable to beginning students. Analyis proceeded as follows:

On each skill, the percentage of students scoring one third or less of the items correct was computed in each group and these percentages were then compared. A "significant difference" was defined as one of ten or more percentage points. Of 74 comparisons, 21 (about one-fifth) of the comparisons were significant. Since some differences would be expected by chance, we concluded that the skill score distributions for beginning students are similar to those for graduating students. Though this does not, of course, guarantee that relations to AIT performance would be the same, it lent support to the verification results based on the graduating students.

Table 2. Skills Related to AIT Course Performance

I. Reading Skills

A. Comprehension of Printed Text

1. Comprehension of procedural directions.

2. Comprehension of paragraphs describing equipment operation.

B. Locating Information in Reading Materials

1. Locating information in outline-form text.

2. Locating information by using a table of contents.

3. Locating a task in a task list

C. Locating and Using Information in Tabular and Diagrammatic Displays

1. Locating information in tables.

2. Identifying connections in cabling diagrams.

3. Using troubleshooting charts to diagnose equipment malfunctions.

II. Skills for Learning from Lectures and Demonstrations

A. Listening Skills

1. Recalling information from lectures or demonstrations without the use of notes.

2. Recognizing deficiencies (missing information) in a lecture or demonstration.

3. Following step-by-step oral directions.

B. Note-Taking Skills

1. Using class notes to revise text in the Soldier's Manual.

2. Answering questions based on notes taken during a demonstration of equipment operation.

Learning Strategies

In order to verify the relationship of learning strategies to AIT performance, we compared reported strategy use in the Highly successful and Marginal criterion groups. Direct comparison between the two groups on each strategy proved impractical because of apparent differences in response set between the two groups. Therefore, the strategies within each category (focus attention, encoding, retrieval, control) were rank-ordered within each group of students on the basis of their degree of reported use. The rank-orderings were then compared between the two groups. The following differences were found:

1. Repetition was ranked higher as a strategy for encoding information in lectures and demonstrations by the Marginal group Group than by the Highly successful group; in the Highly successful group, more sophisticated encoding strategies (e.g., paraphrasing, relating new to previous information) were reported more often.

2. For learning a large set of facts or associations, the Marginal Group most often reported focusing on and studying the items one at a time, whereas the Highly successful group students were more likely to study them in groups of two or more.

3. Whereas Highly successful students tended to focus attention, during demonstrations, on what the instructor was saying, Marginal students were more likely to focus on the equipment, especially the location of various components.

4. During lectures, Highly successful students most frequently reported listening for the main idea, but Marginal students listened primarily for the instructor's verbal markers. These findings support the idea that good students are more able to internally extract the important content of a lecture, whereas poor students are more dependent on external cues to help them decide what is important and what is not.

It is interesting that the same findings concerning strategy use have been reported in comparisons of good and poor college students, despite differences in populations and in subject matter to be learned (Dansereau et al., 1979; Weinstein, 1978).

Recommendations for Skills to Be Included in FBSEP

All the skill clusters listed in Table 2 were recommended for inclusion in the yet-to-be-developed FBSEP course. Two clusters were added to the set: (1) Recognizing a picture of a labeled part of a whole, i.e., a component of a larger piece of equipment, and (2) Prerequisites for scale reading. Though not empirically verified in the analyses described in previous sections, both were judged important based on the frequency of occurrence in 31M10 MOS reading materials and on interviews with AIT instructors.

Verification of Hierarchical Interrelationships among Skills

The last purpose of Stage III Verification was verification of hypothesized hierarchical interrelations among the skills within each cluster. The purpose wan not to add or delete skills from the recommended list but to provide information concerning the order in which skills should be taught. After all, if hierarchical analysis demonstrates that, of two skills to be taught, skill A is prerequisite to skill B, then instructional development must ensure that skill A is taught first. If, on the other hand, herarichcal analysis reveals that the skills are independent, then the order in which they are taught can be based on other considerations.

Hierarchical analysis involved considering pairs of skills hypothesized to be hierarchically related and computing one or more indices. The indices required that each student be assigned a score of "1" (pass) or "0" (fail) on each skill. Therefore, the first step was to convert each student's score on each skill to 1 or 0. this was done by considering any score of 67% or more correct as "1" and scores below 67% as "0."

If skill A is prerequisite to skill B, then skill A must be acquired first; consequently, though some students may have acquired both skills, other students, neither skill, and still other students, skill A but not skill B, no students should have acquired skill B but not skill A. This implies, first, that a larger number of students should be found to possess skill A than skill B. Therefore, the first test for hierarchical interrelatedness between each pair of skills involved comparing the number of students scoring 1 on the two skills. If the number of students scoring 1 on skill B was greater, we concluded that skill A was not prerequisite to skill B and computed no further indices of relationship.

For pairs of skills in which skill A was passed more frequently than skill B, three additional indices were computed: Walbesser"s consistency ratio and adequacy ratio (Walbesser, 1968), and Capie and Jones' necessity ratio (Capie and Jones, 1971). The criterion for verification of the hierarchical relationship between any two skills was ratios of .75 or more on all three indices.

Results

The results of the hierarchical analysis will be discussed in relation to each of the skill areas listed in Table 2. PT is used to represent "prerequisite to."

I. Reading Skills

A. Comprehension of Printed Text. We had hypothesized the following relationships:

1. word knowledge PT comprehension of simple procedural directions (one sentence, active voice, no dependent clauses, single action)

2. comprehension of simple procedural directions PT comprehension of complex-sentence procedural directions (one or two sentences, multiple actions and/or passive voice and/or dependent clauses)

3. comprehension of complex-sentence procedural directions PT comprehension of papragraphs describing equipment or equipment operation.

Though the second hypothesized relationship was verified, the others were not. We concluded that, though comprehension of complex sentences depends on comprehension of simple ones, the difficulty of words, sentences, and paragraphs relative to one another depends on the particular content, meaning, and structure of each. For example, some words are harder to understand than some sentences in Army reading materials. And paragraphs describing simple equipment or equipment operations are easier to understand than some sentences describing procedural directions.

B. Locating Information in Printed Materials. We had hypothesized that locating information in outline-form text with few levels of headings was prerequisite to locating information in outliies with many levels of headings. The relationship was verified.

C. Locating and Interpreting Information in Tabular and Diagrammatic Displays. We had hypothesized the following relationships:

1. distinguishing rows and columns PT locating information in a table or cabling diagram

2. Interpreting column headings PT locating information in particular cells of the table

3. locating information in tables without keys PT locating information in tables with keys

4. identifying connections in a two-system cabling diagram PT identifying connections in a three- or four-system cabling diagram.

5. interpreting and locating malfunctions in a trouble-shooting chart for single-indicator malfunctions PT the same skills for multiple-indicator malfunctions.

The first and second relationships were not verified. This suggests that users can sometimes locate information in tables even without understanding their structure or the meanings of the column headings. The fourth relationship also was not verified; students' ability to identify connections in cabling diagrams was independent of the number of inter-connected systems. However, the third and fifth relationships were verified. Ability to use tables without keys was prerequisite to using tables with keys. And using a troubleshooting chart for multiple-indicator malfunctions depended on being able to use the tables for single-indicator malfunctions.

II. Skills Involved in Listening to Lectures and Watching Demonstrations

A. Listening Skills. No particular relationship had been hypothesized among these skills. Though we assumed variation in difficulty and complexity within each component skill, no particular hierarchical relationship had been hypothesized among them.

B. Note-Taking Skills. We had nypothesized note-taking during a "simple" demonstration (simple equipment, few steps in the demonstrated procedure) PT note-taking during a "complex" demonstration (complex equipment, more steps in the demonstrated procedure). The relationship was not verified. Surprisingly, students tended to score higher on questions based on the complex than the simple demonstration used in the test. This suggests that the difficulty level of note-taking and note-using may be influenced by other factors, e.g., instructor's clarity, student interest.

Two other skill areas were recommended for FBSEP instruction - recognizing a picture of a labeled part of a whole, and scale-reading prerequisites (see p. 11). In the case of the former, no hierarchical relationships had been hypothesized. For scale-reading prerequisites, we had hypothesized reading values on an unnumbered whole-number scale PT reading values on an unnumbered scale calibrated in tenths. This relationship fell just short of the criterion for verification (two of the three ratios were greater than .75).

In summary, some but not all the hypothesized hierarchical inter-relationships were verified. Most of the verified relationships fell in the area of reading skills, the most thoroughly studied basic skill. Relationships were less clear in the areas of listening and notetaking. The results of hierarichical verification provided useful guidelines for our work in the nex phase - design and development of the FBSEP course.

DESIGN AND DEVELOPMENT OF THE FBSEP COURSE

Design of the FBSEP course involved defining its major components, their sequence and their placement relative to the AIT course, and deciding on the content and structure of the instructional materials. One of the major components was a test to identify students with basic skill deficiencies and to assign them to appropriate instruction. Construction and validation of the test, which took place concurrently with course design and development, are described in the next section of this paper. This section focuses on the design and development of the instruction itself.

Definitions and Ordering of Lessons

The skills listed in Table 2, plus recognizing a picture of a labeled part of a whole and scale-reading, were organized into nine units of instruction, each corresponding approximately to one skill area. The units are listed in Table 3. The table also includes the basis for inclusion of that unit.

Table 3. FBSEP Units and Their Relationship to Verified Skills

UNIT	TITLE	CORRESPONDENCE TO VERIFIED SKILLS
I	Reading Comprehension	Comprehension of printed text.
II	Using a Table of Contents	Locating information by using a Table of Contents.
III	Listening Skills	Listening skills.
IV	Note-Taking for Demonstration	Note-Taking skills.
V	Recognizing a Part of a Whole	Recognizing a part of a whole.
VI	Locating Information in Tables	Locating information in tables.
VII	Reading Cabling Diagrams	Identifying connections in cabling diagrams.
VIII	Diagnosing Equipment Malfunctions	Using troubleshooting charts to diagnose equipment malfunctions.
IX	Scale Reading	Scale reading prerequisites.

Each unit was further broken down into lessons, each corresponding approximately to one verified skill (though sometimes several skills were incorporated in one lesson). Results of the hierarchical analysis were used to order the lessons and the component skills within lessons. The lessons are listed in Table 4. The intent was that students assigned to more than one lesson within a unit would go through the lessons in the order listed. However, with a few exceptions, any combination of lessons within and between units could be assigned, dependent on test results.

The contract required that FBSEP instruction be integrated with the AIT course as much as possible. However, extensive integration proved to be unfeasible for both instructional and logistic reasons. Instructionally, most of the FBSEP skills were needed either from the start of the AIT course or within one week after its start. Pulling soldiers out of AIT soon after its beginning seemed too disruptive to the continuity of AIT training, especially since the AIT course was instructor-paced and group-administered, so that removal would probably mean re-entering the course later with a different group of students. Logistically, too, the Army preferred minimal movement of students between FBSEP and AIT. Front-loaded instruction not only avoided these problems but also, since the AIT course always began on a Wednesday, permitted students requiring only a few FBSEP lessons to receive them on Monday and Tuesday and to continue to the AIT course as originally scheduled.

One unit was an exception. Unit VIII included skills necessary for using TM troubleshooting charts which were first used in Week 5 of the AIT course. Futhermore, learning to use such tables is considerably facilitated by some knowledge of the equipment to which they refer. For these reasons, Unit VIII was integrated into the AIT course; students needing instruction in that unit received the lessons at the end of Week 4.

Lesson Design

Student lesson materials (Student Guides), other needed media and materials, and instructor materials were prepared next. The contract required that FBSEP instruction be individualized and self-paced, with little need for instructor intervention. In order to make this possible, each lesson was designed to have the following characteristics.

1. Explicit statement of learning objectives.
2. Self-instructional materials.
3. Frequent, built-in opportunities for student response.
4. Immediate feedback for all responses.
5. Criterion-referenced testing.

The characteristics are discussed below.

Table 4

Units and Lessons

Unit	Lesson	Title
I Reading Comprehension	1	Vocabulary
	2	Strategies for Understanding Sentences
	3	Reading Negative Sentences
	4	Reading Sentences With Dependent Clauses
	5	Ordering One, Two, or Three Tasks
	6	Determining the Order of Steps: Multiple Actions
	7	Understanding Lists and Paragraphs
II Using a Table of Contents	1	Chapters and Sections
	2	Using a Task List to Find a Task Description
	3	Tables with Paragraph Numbers and Page Numbers
III Listening Skills	1	Remembering Information Heard in Lectures
	2	Remembering Information Seen in Demonstrations
	3	Recognizing When Important Information Is Missing
IV Note-Taking for Demonstrations	1	Basic Note-Taking Skills
	2	Taking Notes to Show Sequence
	3	Taking Notes to Show Relationships
V Recognizing a Part of a Whole	1	Recognizing a Part of a Whole
VI Locating Information in Tables	1	The Structure of Tables and Diagrams
	2	Interpreting Table Headings
	3	Locating Information in 31M Tables
VII Reading Cabling Diagrams	1	The Structure of Tables and Diagrams (Same as Unit VI, Lesson 1)
	2	Identifying Connections in Simple and Complex Cabling Diagrams
VIII Diagnosing Equipment Malfunctions	1	Deciding whether an Indication Is Normal
	2	Deciding Whether There Is Something Wrong Based on 2 or More Indicators
	3	Finding Descriptions of Symptoms: One Indicator
	4	Finding Descriptions of Symptoms: Two or More Indicators
IX Scale Reading	1	Labeling Place Value
	2	Numbering Scale Points
	3	Scales Divided into Tenths
	4	Comparing Scale Settings

Explicit Statement of Learning Objectives

Learning objectives, statements of what the student was expected to be able to do after instruction, were to be stated clearly and made available to both student and instructor in each lesson. In each lesson, the final goal of the lesson was explicitly stated as a terminal objective. And the various subgoals which the student must attain on the way toward the terminal objective were stated as enabling objectives. Each objective included the action to be performed, the conditions under which the action would be performed, and the standard to be met. In the Student Guides, objectives were called "Learning Goals" and stated in terms the student could understand.

Self-Instructional Materials

Most student learning materials for each lesson were to be contained in the Student guides, so that students could use them with minimal intervention by the instructor. Therefore, each Student Guide was written to contain: (1) all the material to be learned and (2) instructions for proceeding through the material. Both were written to be self-explanatory. The language was kept simple so that even relatively poor readers should have little difficulty comprehending it. Instructions were explicit and easy to follow.

Frequenty-built-In Opportunities for Student Response

A new behavior being acquired needs to be strengthened and maintained through practice. Therefore, each Student Guide included numerous exercises in which the student practiced a new behavior(s) by answering questions. All students received these built-in opportunities to practice. In addition, if a student's performance on a test indicated that the skill had not yet been mastered, opportunities for additional practice, also self-instructional, were made in the form of Review Exercises, intended to provide additional practice on the same skills using new material.

Immediate Feedback for All Responses

Research has demonstrated the importance of immediate feedback for learning. The FBSEP materials were designed so that immediate feedback occurred regularly and often. The decision was made to have students check their own answers to exercises in most cases immediately after answering them. By verifying correct answers, students received immediate reinforcement for their responses, hence for the learning which enabled the students to make the correct responses. In the case of incorrect responses, students could compare the correct answers with their own and receive immediate corrective feedback, which would increase the probability of correct responses in the future.

Criterion-Referenced Testing

Each lesson contained at least one test, administered and corrected by the instructor. Tests were called checkpoints and measured important enabling objectives and the terminal objective. All the FBSEP checkpoints were criterion-referenced, so that students, as well as instructors, knew ahead of time what kinds of things they would be expected to do on a checkpoint, though, of course, the did not know exactly what questions would be asked.

Checkpoints were short, usually (but not always) ten items long. A variety of question types were used - completion, fill-in-the-blank, matching, and multiple-choice. The cutoff point for successful completion of the checkpoint was 80-85% correct.

Development of Materials

Once general guidelines for course development had been specified, an outline to guide development of each lesson was prepared. An example for the lessons of Unit VIII is included in Appendix A. Lesson writers then developed the actual lesson materials in accordance with the general guidelines and the lesson outlines. First, enabling objectives were derived for each lesson. Instructional material was developed to teach the lesson, beginning with the lowest-level enabling objective, followed, successively, by the remaining enabling objectives until the terminal objective was reached.

Materials derived from or closely related to the 31M10 course and MOS were used in the Student Guides and Review Exercises. Care was taken to keep language used for presenting and explaining the material clear and simple, so that even poor readers would have little trouble with comprehension. Especially in long lessons, both the reading matter and the self-correcting exercises were varied in order to sustain student interest.

In the checkpoints constructed for each lesson, care was taken to ensure that each item measured the relevant objective, was clearly stated, and was unambiguous. Since checkpoint questions were parallel to those found in self-correcting exercises of the same lesson, students who had done well on the exercises (i.e., had attained the objectives) could be expected to do well on the checkpoint, too.

Though most lessons included all the media and materials required for learning, two units (III, Listening and IV, Note-Taking) made extensive use of non-print media, specifically audio and videotapes. Scripts for these lessons were written by lesson developers, and the tapes themselves were produced by the Army using Army instructors as lecturers.

There are disadvantages to using mediated presentations, used by individual students, in simulating actual classroom conditions. For example, if students misunderstood something or needed clarification, they were unable to request help from the instructor. In addition, AIT lectures and demonstrations were presented in a group setting, not to individual students. Nevertheless, the individualized nature of the FBSEP course, in particular, the fact that different students would be working on different lessons at the same time, made mediated presentations essential.

Development of the Instructor Guide

Since the instructor's role in a self-paced course such as this differs from that in traditional group instruction, an Instructor Guide was written which included introductory sections on the role and functions of the FBSEP instructor. The introduction also included information on the content, structure, and sequence of the course. The body of the Instructor Guide consisted of guides for individual lessons. These included the following information about each lesson:

- terminal objective
- estimated lesson length
- method of instruction (a summary of needed materials)
- other media and support materials
- references for additional information, if needed
- lesson structure
- enabling objectives
- testing, including scoring keys for checkpoints
- instructional guidelines

A sample lesson guide from the Instructor Guide can be found in Appendix B.

Small-Group Tryout

The next step in instructional development was small-group tryouts of the lessons in all units but III and IV.* For this purpose, five subjects, recent high school graduates or dropouts, between 18 and 22 years of age, were paid to participate. Each lesson was completed by at least three of the subjects. We attempted to make the conditions as similar to those of the FBSEP classroom as possible. When a subject completed all the components associated with a given lesson, time required for completion and checkpoint scores were recorded. The subject was then interviewed by the lesson developer to pinpoint possible trouble spots.

* Delays in media production prevented these lessons from being ready on time.

Unit VIII, requiring some knowledge of 31M10 equipment, could not be tried out with civilian volunteers. For these lessons, three students from the AIT course were used.

Lesson Revision

A number of problems - some anticipated and others unexpected - surfaced during small-group tryouts. Some lessons were too easy, long, and repetitious. Others, judging from poor checkpoint performance and subjects' confusion, were too short or insufficiently elaborated. Almost all lessons required some changes, though few required extensive ones. The indicated changes were made, and the revised lesson materials were submitted to the Army for examination and for printing.

CONSTRUCTION AND VALIDATION OF A SCREENING TEST

ASA had contracted to develop a FBSEP course in which students would receive instruction in all thos skills, and only those skills, in which they were deficient. Thus, a test was needed to (1) identify students who required FBSEP instruction and (2) assign the students to the appropriate units and lessons within units.

A two-stage testing process was devised. A single Level I test was constructed to identify units with deficiencies (if any); multiple Level II tests, one for each unit,* were constructed to determine the specific lessons within units for which instruction was to be prescribed. All students assigned to 31M10 AIT would take the Level I test. Those scoring above the cutoff on all units would continue directly to the AIT course. Those scoring below the cutoff on any unit(s) would take the Level II tests for those units. They would be assigned to FBSEP lessons in which Level II scores were below cutoff, and would receive any prescribed (front-loaded) FBSEP instruction prior to entering the 31M10 AIT course. We decided to call the Level I test the Screening Test and the Level II tests, Diagnostic Tests. The sections which follow describe their construction.

Test Construction

Item Selection and Assignment to Tests

The multiple-choice items constructed for stage III verification provided the item pool for the Screening and Diagnostic Tests. Performance on the items by the 163 beginning students who were tested during verification provided data for item selection. Indices of item difficulty (p) and item discrimination (r_{pbi}) were computed for items measuring skills for which FBSEP instruction was to be designed. Based on the results, six items were selected from each lesson.

Next for most units, a random two of the six items for each lesson were placed in the Screening Test, the other four in Diagnostic Tests for the appropriate units. For example, since Unit I included eight lessons, the Screening Test included sixteen items from Unit I, two from each lesson; the Diagnostic Test for Unit I included 32 items, four for each of the eight lessons.

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* Units III, IV, and V were exceptions to the two-stage testing process, for reasons to be explained later.

Units III, IV, and V were exceptions to the procedure described above. The items for Unit III, Listening Skills, and Unit IV, Note-Taking Skills, required administration of audio- or video-tapes. The use of such AV materials would be difficult to manage in the Diagnostic Tests, with different students taking different combinations of tests. Therefore, all Unit III and IV items were included in the Screening Test, and lesson as well as unit assignments for these units were made from Screening Test administration alone.

Since Unit V contained only one lesson, assignment to the unit necessarily implied assignment to the lesson. Therefore, all six unit/lesson items were placed in the Screening Test, and lesson assingment made on that basis.

Administration and Scoring

The Screening Test and Diagnostic Tests were designed to be administered on two successive days. Immediately after administration of the Screening Test to all beginning 31M10 students, the test was scored, yielding a score for each unit. Students who scored above cutoff on all units were dismissed from further testing. Students who scored below cutoff in any units other than III, IV, or V were directed to return the next day for Diagnostic Testing; in Units III, IV, and V, scores below cutoff resulted in assignment to lessons in those units without further testing.

On the second day, students who had been instructed to return took the Diagnostic Tests for units in which they had scored below cutoff. Each Diagnostic Test yielded a score for each lesson in the unit, and students were assigned to lessons in which they scored below the cutoff.

Cutoff points were set as follows. In the Screening Test, the cutoff for each unit was between 67 and 75% correct. (Since different units had different numbers of items, no single score could be used.) The Diagnostic Tests included four items for each lesson, and the cutoff point was set at a score of three. Thus, assignment to a given lesson in FBSEP was based on a score of 0, 1, or 2 on the Diagnostic Test items for that lesson. Hypothetically, then, a student might be assigned to any number of lessons, from none to 36, depending on Screening and Diagnostic Test performance.

Test Validation

The purpose of test validation was to determine the reliability of the Screening and Diagnostic Tests and their validity in identifying students who were likely to experience academic difficulties in the 31M10 AIT course. Data for validation were obtained by testing 155 students scheduled to begin the course over four weeks, then collecting AIT performance data on all the students over the following eleven weeks.

We called this group the Control Group, because, though tested for entry to FBSEP, none of them received any "prescribed" instruction, since the course was still in the process of development. All 155 students took the Screening Test as well as all the Diagnostic Tests.

Test Reliability

For the purpose of assessing test-retest reliability, the Screening and Diagnostic Tests were readministered to the same students one week after the initial testing. A test-retest reliability coefficient was computed for each unit of the Screening Test.* Reliability coefficients ranged from .193 to .675. The low coefficients were not unexpected, given the small number of items in most units and the restriction of range, with most students answering most items correctly, as is common in minimal competency tests.

A more meaningful index of test-retest reliability for a test of this type is one based on the consistency with which students score either above or below cutoff on both administrations. For each unit of the Screening Test, such an index reflects the consistency with which students were assigned (or not assigned) to take the Diagnostic Test for that unit. And, for each lesson of the Diagnostic Tests, such an index reflects the consistency with which students were assigned (or not assigned) to instruction in that lesson.

An index of consistency was computed for each unit (except Units III and IV) of the Screening Test and for each lesson of the Diagnostic Tests by the following method:

$$\text{Index of Consistency} = \frac{\text{Number of students consistently above or below cutoff on both administrations}}{\text{Number of students tested}} \times 100$$

The lesson indexes were computed using only students who had scored below cutoff on the corresponding unit(s), since they were the only ones who would be taking the lesson tests.

Unit consistency indices were 75% or more in all units except one (Unit VIII). Lesson indices tended to be somewhat lower; however, all but four were above 60%. We concluded that the tests showed adequate reliability in both unit and lesson assignment.

* Units III and IV were not retested, since a second administration of the same audio- and video-tapes would have resulted in inflated scores. For those units, the split-half reliability was computed.

Test Validity

The ability of the tests to identify students who, without FBSEP, would experience difficulty in the AIT course was determined by computing the following measures of relationship between test performance and performance in the AIT course;

1. a multiple regression equation predicting course performance from Screening Test unit scores.

2. a comparison of students falling in various AIT criterion categories on the Screening and Diagnostic Tests.

Multiple Regression. For each student in the Control Group, a course performance measure was computed by adding all his/her AIT test scores. This measure was called TESTSUM. The ability of the Screening Test to predict TESTSUM was determined by computing the multiple regression equation for predicting TESTSUM from the Screening Test's unit scores. The regression effect was significant ($p < .01$) with $R^2 = .22$. Of the nine units, Units III and IV (Listening and Note-Taking Skills) accounted for more TESTSUM variance than any other units, thus contributing most to accurate prediction.

Comparison of Criterion Categories. Based on their AIT performance, Control Group students were divided into four criterion groups; the first three were the same as those used during verification (see p. 9):

I. Highly successful students, who never failed an AIT test or any part of the end-of-course (EOC) test.

II. Moderately successful students, who either failed one or more AIT tests, or failed one or more parts of the EOC test, but not both.

III. Marginal students, who failed one or more AIT tests and also one or more parts of the EOC test.

IV. Students who did not complete the AIT course.

Test scores of these four criterion groups were compared in the following ways:

1. For each unit of the Screening Test, a X^2 test was used to compare the distribution across criterion groups of students who scored above and below cutoff. Five of the nine X^2's were significant ($p. < .05$). In each case, scores below cutoff were associated with membership in the less successful criterion categories.

2. The number of Screening Test units below cutoff was computed for each student, and this was related to criterion category membership. A X^2-test showed that the relationship was significant ($p < .02$); the greater the number of unit scores below cutoff, the greater the likelihood of membership in less successful criterion categories.

3. Similarly, the number of Diagnostic Test (lesson) scores below cutoff was related to criterion category membership. X^2 was significant at the .001 level. That is, the greater the number of FBSEP lesson required (according to Diagnostic Test scores), the greater the likelihood of falling in one of the less successful criterion categories.

In sum, data collected on 155 students entering the 31M10 AIT course showed that both the Screening and Diagnostic Tests were reliable in consistently assigning (or not assigning) students to FBSEP instruction, and that the tests were successful in identifying students who were likely to experience difficulty in the AIT course. We concluded that test validity had been adequately demonstrated and that the tests would serve the purpose for which they had been designed.

DEVELOPMENT AND DELIVERY OF INSTRUCTOR TRAINING

The Army hired six civilian instructors to teach the FBSEP course. All were certified to teach at the secondary level, and most had had additional courses or experience in working with adult learners. The FBSEP course, however, differed considerably from traditional group instruction. An instructor-training course was developed to familiarize the instructors with the media, materials, and delivery system of the course and to provide practice in the instructor's role.

The five-day course was conducted just prior to the start of FBSEP tryout and validation by a FBSEP developer. The "textbook" for training was the FBSEP Instructor's Guide. During the five days, the six instructors:

- were presented an overview of FBSEP course development.
- visited the 31M10 AIT course to observe firsthand the content and course delivery system.
- examined AIT course materials in relation to the FBSEP course content.
- discussed student and instructor roles in FBSEP.
- tried out a few FBSEP lessons themselves.
- examined all FBSEP lessons to learn their components and their teaching requirements.
- completed worksheets with questions concerning instructor roles, and content and delivery of particular lessons.
- held discussions about teaching methods, management techniques, and how to deal with possible problems.
- prepared three classrooms for the students who were to start the following week (stored and labeled lesson materials, hooked up videotape players, etc.).

At the end of the week, the instructors took a written test with 12 open-ended questions based on the week's training. Each question was graded on a pass-fail basis. Since all but one instructor (who scored 9) answered 10 or more questions correctly, the training was judged to have been adequate.

Instructors were encouraged to make suggestions and criticisms of their training throughout the week. This feedback resulted in some revisions. In addition, to make it possible for Army personnel to conduct the training without help from the developers, the following printed materials were produced:

Student Guide for Instructor Training Course

Trainer Guide for Instructor Training Course

Course Management Plan for Instructor Training Course

Though the content remained much the same as in the original, the revised course was more (though not entirely) self-instructional, included more worksheets, and added some role-playing exercises for additional practice of the instructor role.

VALIDATION OF THE FBSEP COURSE

Validation of the FBSEP course consisted of a large-scale tryout of all its components with students who had completed their basic training and were scheduled to begin the 31M10 AIT course. The purpose was to answer the following questions: How many students are assigned to various lessons and combinations of lessons? How long does it take students to complete each, and all, their assigned lessons? Are the students successful in acquiring the skills they are taught? To what extent are the skills retained one to two weeks later?

To provide data for answering these questions, 235 incoming AIT students over a seven-week period took the Screening Test, and, if their unit scores warranted it, the relevant Diagnostic Tests. Students whose test scores indicated deficiencies were assigned to and received the needed lessons. We called this group the "Experimental Group" in contrast to the Control Group tested during test validation but not provided with FBSEP instruction, even if needed.

Students completed their assigned lessons in the prescribed order. After each lesson, each student completed a Lesson Evaluation Checklist (see Appendix C) before going on to the next lesson. Records were kept of time spent per lesson and checkpoint scores. One to two weeks after completion of their last lessons, students were given posttests, parallel to the lesson checkpoints, for all lessons completed.

Validation Results

Number of Students Assigned to FBSEP and Time Required for Completion

The distribution of number of lessons per students was highly positively skewed. Of the 235 students tested, 130 passed all units of the Screening Test, hence required no FBSEP training. Most of the rest (44.7%) were assigned to less than four lessons. All students except one required 14 lessons or less (That poor soul received 22!).

Two lessons (1 and 2 of Unit I) required an average of 5 to 8 hours to complete, but most averaged 2 hours or less. Since, in addition, most students were assigned to few lessons, the total length of time in FBSEP per student tended to be relatively short. In fact, most students completed all prescribed front-loaded instruction in two days (Monday and Tuesday) and were ready to proceed to the AIT course on Wednesday with their classmates.

Evidence Regarding Skill Acquisition

Table 5 shows, for each lesson, the number of students completing the lesson and, for those lessons completed by at least five students, the percentage who passed the final checkpoint and the posttest. In both cases, a "pass" required a score of 80% or more correct.

Table 5. Checkpoint and Posttest Performance on All Lessons

Unit	Lesson	Number of Students	Percent Passing Final Checkpoint	Persons Passing Posttest
I	1	8	62	50
	2	9	62	56
	3	10	80	40
	4	1	*	*
	5	17	94	47
	6	5	100	80
	7	9	100	33
II	1	.1	*	*
	2	3	*	*
	3	4	*	*
III	1	14	93	29
	2	8	100	0
	3	10	20	0
IV	1	30	93	47
	2	23	91	17
	3	27	93	30
V	1	3	*	*
VI	1	9	100	56
	2	24	100	83
	3	20	90	55
VII	2	8	75	38
VIII	1	5	100	100
	2	9	100	100
	3	19	100	100
	4	19	100	79
IX	1	14	100	79
	2	11	100	82
	3	22	100	55
	4	12	100	50

* Insufficient Data

If passing performance on the final checkpoint by at least 80% of the students is used as a criterion, it is clear that most lessons were successful in teaching the lesson skills. The exceptions were Lessons 1 and 2 of Unit I, Lesson 3 of Unit III, and Lesson 2 of Unit VII (though this lesson fell just short of the 80% criterion). Lessons 1 and 2 of Unit I both covered broad and fairly general reading skills (word knowledge and strategies for sentence comprehension). Though these lessons were the longest in the course, they were apparently too brief to improve such broad reading skills significantly. Lessons focusing on more specific skills (e.g., reading procedural directions and descriptions of equipment using troubleshooting charts) were more successful.

Lesson 3 of Unit III, "Recognizing When Important Information is Missing," also failed to meet the 80% acquisition criterion. This lesson attempted to teach a fairly high-level metacognitive skill (comprehension monitoring) which even many college students lack (Brown et al., 1981). In addition, this lesson is one of those which were not available for small-group tryout due to delays in media production; tryout data might have yielded valuable information for lesson revision prior to the validation trials.

Evidence Regarding Skill Retention

Though over 80% of students passed the final checkpoint of most lessons, the percent of students passing the posttest one or two weeks later was often significantly lower. Lessons which showed marked drops from checkpoint to posttest performance included most reading lessons (Unit I), all of units III and IV, two out of three lessons in Unit VI, and two of the four lessons in Unit IX. In most cases, this suggested that more practice needed to be built into the lessons, and perhaps also greater incentives for practicing the skills.

The drop-off in scores in Units III and IV, Listening and Note-Taking skills, was particularly disappointing. Our course analysis and evidence from verification and test validation all pointed to the centrality of these skills for succession the 31M10 AIT course. According to the course validation data, most of the skills were attained but rapidly lost. It is difficult to attribute this entirely to the lessons alone; if instruction were truly inadequate, the skills would not have been attained in the first place. It is possible that posttest administration may have been faulty; the posttests, which required media as did the lesson checkpoints, were administered by personnel who were neither course developers nor FBSEP instructors. However, it was not possible to determine whether this was the case. In any case, it is probable that additional development work and revision were called for in Units III and IV.

The unit with the best overall retention rate was Unit VIII, the only unit integrated with the AIT course. This supports the idea that skills which are applied immediately or very soon after initial acquisition are best retained.

Lesson Revision

Lessons which failed to meet the acquisition criterion, the retention criterion, or both were revised. However, re-validation was not possible within the constraints of the time and resources available.

Lesson revisions were based primarily on error analyses of checkpoint and posttest performance. If checkpoint errors indicated a particular source of difficulty, suggesting a lack of clarity in the lessons, relevant sections of the lesson were rewritten. The evaluation checklists completed by the students were particularly helpful in suggesting the types of changes which were needed. If discrepancies between checkpoint and posttest scores indicated adequate acquisition but poor retention, additional exercises were built in to provide more practice. The revised materials were submitted to Army officials with the suggestion that a re-validation be conducted.

SUMMARY AND CONCLUSIONS

In 1981, Applied Science Associates, Inc. contracted with the Army to develop and validate a FBSEP course for soldiers about to begin AIT training for the 31M10 MOS. The project extended over almost two years and involved six phases. The phases were

Phase 1. Analysis of the 31M10 AIT Course to Identify Prerequisite Skills

The course materials and delivery system were analyzed, using a Gagne-type procedure, to identify skills needed for success. The identified skills included traditional basic skills (functional reading, math), other not-so-traditional skills (e.g., listening, note-taking), technical knowledge, and learning strategies.

Phase 2. Verification of the Identified Skills

A three-stage verification process was conducted to assess the reliability of skill-identification, the relationship of the skills to AIT performance, and the hypothesized hierarchical interrelations among the skills. Based on the results, recommendations were made concerning skills to be taught in FBSEP and the order for teaching them. The recommended skills fell in two major classes - reading skills (especially for procedural directions, photographs, tables, and troubleshooting charts) and listening and note-taking skills (for lectures and demonstrations on equipment operation). Some quantitative skills (scale-reading prerequisites) were also included.

Phase 3. Design and Development of the FBSEP Course

In this phase, decisions were made concerning course structure, delivery and media, and integration with the AIT course. the course was divided into nine units (skill areas), each to contain one or more lessons. The lessons were designed to be self-instructional, insofar as possible, so that different students could work on different lessons at the same time. Instruction was delivered via printed consumable workbooks (Student Guides); in lessons on listening and note-taking, these were supplemented by audio and/or videotapes. Most lessons were designed to be front loaded; however, one unit, involving skills needed for diagnosing equipment malfunctions using troubleshooting charts, was to be taught just prior to the first AIT lessons on troubleshooting. Instructional materials (Student Guides, Instructor Guide, tests, Review Exercises, tests, and other media) were developed for all lessons. Terminal and enabling objectives were derived, and the lessons written. Small group tryouts resulted in several revisions prior to full-scale validation.

Phase 4. Test Construction and Validation

A two-stage testing process (Screening Test and Diagnostic Tests) was devised for identifying students with deficiencies and assigning them to appropriate lessons. A large-scale tryout demonstrated that both tests were consistent in assigning students to units/lessons, and that test performance was significantly related to success in the AIT course.

Phase 5. Development and Delivery of Instructor Training

Six instructors were trained, in a five-day course, to deliver FBSEP instruction.

Phase 6. Validation of the FBSEP Course

Immediately after the end of instructor-training, the large-scale tryout of the FBSEP course began. Students selected for 31M10 AIT training were tested, and those who, according to their scores, were deficient in one or more prerequisite skills, were assigned to and received the needed lessons. Data were collected on number of students assigned to FBSEP, number of lessons per student, time to completion, performance on lesson tests (checkpoints), and performance on posttests one week later. The findings included:

1. About 45% of beginning 31M10 students were assigned to one or more FBSEP lessons.

2. About half these students were assigned to one, two, or three lessons.

3. With few exceptions, students completed all assigned lessons within two days and proceeded to the AIT course as scheduled.

4. In most lessons, over 80% of the students completed the lesson satisfactorily (checkpoint score of 80% or more correct). However, performance often dropped markedly over one week; posttest scores were generally considerably lower than checkpoint scores. the exceptions were primarily in the lessons of Unit VIII, which were integrated with the AIT course. In these lessons, posttest scores remained high.

Lessons which failed to reach the validation criteria were subsequently revised to provide clearer explanations and more practice for strengthening the skills being taught. However, since the contract was nearing its end, no time remained for re-validation of the revised lessons. Nor was it possible to follow up the trained soldiers as they proceeded through the AIT course to determine whether their course performance was improved, relative to soldiers who also needed but did not receive FBSEP instruction.

Though lesson revision is likely to result in the strengthening, hence better retention, of FBSEP skills, greater emphasis on motivation as well as skills may be important. This is suggested by the high rate of posttest success on lessons integrated with the AIT course. In this case, the students had the opportunity to apply their new skills immediately, and the relation of the skills to the AIT course was obvious. Such relationships need to be brought out more clearly for all lessons, either by explicit examples in front-loaded instruction or by a greater degree of integration of FBSEP with the AIT course. Instructionally, the latter course is preferable; however, it would be difficult in a group-paced AIT course like the 31M10.

Our analysis of the 31M10 course yielded some skills which were highly specific to materials used in the course, e.g., skills for analyzing printed descriptions of equipment malfunctions in particular kinds of troubleshooting charts. Such a micro-level of analysis and training has rarely been attempted in basic skills instruction, in either the military or civilian sectors. Though highly specific to particular reading materials, such training is likely to yield greater improvement in these specific skills than more general literacy training. Of course, the trade-off is that such specific skills are less generalizable to other reading tasks. The decision that must be made is whether one wants persons who can apply basic skills to one specific task or persons who can apply their skills, perhaps less well, in a variety of contexts. A compromise can probably be reached by using training materials from a greater variety of sources, e.g., using troubleshooting charts from several MOSs, rather than just one to teach reading skills for diagnosing equipment malfunctions.

Can the procedures and results of this work with one MOS be generalized to other MOSs as well? We believe that they can. Though jobs vary widely in the Army, most use similar methods and materials. For example, though different TMs are used in different MOSs, all are written in the same style, include the same kinds (syntactic structures) of procedural directions, the same types of tables, graphs, troubleshooting charts, etc. And all Army AIT instructors are trained to deliver lectures and demonstrations in much the same way ("the Army way").

We believe that instruction for adults deficient in basic skills is essential not only in functional reading, writing, and math skills, but also in functional listening and note-taking skills. Much learning in AIT courses take place through lectures and other types of oral instruction. Oral instruction is also common in other military as well as civilian courses. Skills for learning from these delivery modes have been sadly neglected, both in research and practice. We strongly recommend that more systematic research be conducted on the development and training of these skills, and that such training be incorporated more widely in basic skill instruction.

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Components of the FBSEP Course

Instructional Materials and Tests

Student Guides for all lessons.

Checkpoints for all lessons.

Review Exercises for all lessons.

Instructor Guide

Other Components

Course Management Plan

Diagnostic Test Model (Includes Screening and Diagnostic Tests and instructions for administration and scoring)

Instructor training materials:

Student Guide for the Instructor Training Course

Student Guide for the Instructor Training Course

Management Plan for the Instructor Training Course

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Appendix A

Example of Lesson Outlines for Unit VIII

UNIT VIII

Diagnosing Equipment Malfunctions

Lesson 1

TERMINAL OBJECTIVE: Compares obtained result with description of normal indication on one indicator. If obtained result matches description, classifies as normal.

A. Condition - Given a description of a normal indication on one indicator, and given the obtained result either matching or not matching the description.

B. Standard - Student decides whether there is anything wrong.

C. Instructional Strategy -

Early Stage	Description and examples of normal indications on one indicator and corresponding obtained results. Guidelines for deciding if results given are normal. Work sheet questions.
Middle Stage	Student makes decisions based on low-level normal indication/result problems. Curriculum embedded test.
Final Stage	Student decides if anything is wrong based on higher-level normal indication/result problems. (See A. Condition above).

D. Media - Lesson booklet

E. Estimated Hours of Instruction - 2

UNIT VIII

Diagnosing Equipment Malfunctions

Lesson 2

TERMINAL OBJECTIVE: Compares obtained result with description of normal indication on two or more indicators. If obtained result matches description, classifies as normal.

A. Condition - Given a description of a normal indication including two or more indicators, and given the obtained result on all indicators, with all, some, or none of the indicators matching the description.

B. Standard - Student decides whether there is anything wrong.

C. Instructional Strategy -

Early Stage	Description and examples of normal indications on two or more indicators and corresponding obtained results. Guidelines for deciding if results given are normal. Work sheet questions.
Middle Stage	Student makes decisions based on low-level normal indication/result problems. Curriculum embedded test.
Final Stage	Student decides if anything is wrong based on higher-level normal indications/results problems. (See A. Condition above).

D. Media - Lesson booklet

E. Estimated Hours of Instruction - 2

UNIT VIII

Diagnosing Equipment Malfunctions

Lesson 3

TERMINAL OBJECTIVE: Compares obtained result with description of symptom including one indicator. If obtained result matches description, classifies as abnormal.

A. Condition - Given a description of a symptom including one indicator, and given an obtained result either matching or not matching the description.

B. Standard - Student decides whether there is anything wrong.

C. Instructional Strategy -

Early Stage	Description and examples of symptoms with one indicator and corresponding obtained results. Guidelines for deciding if results given are abnormal. Work sheet questions.
Middle Stage	Student makes decisions based on low-level symptom/indicator/results problems. Curriculum embedded test.
Final Stage	Student decides if anything is wrong based on higher-level symptom/indicator/results problems. (See A. Condition above).

D. Media - Lesson booklet

E. Estimated Hours of Instruction - 2

UNIT VIII

Diagnosing Equipment Malfunctions

Lesson 4

TERMINAL OBJECTIVE: Compares obtained result with description of symptom including two or more indicators. If obtained result matches description, classifies as abnormal.

A. Condition - Given a description of a symptom including two or more indicators, and given the obtained result on all indicators, with either all of them or none of them matching the description.

B. Standard - Student decides whether there is anything wrong.

C. Instructional Strategy -

Early Stage — Description and examples of symptoms with two or more indicators and corresponding obtained results. Guidelines for deciding if results given are abnormal. Work sheet questions.

Middle Stage — Student makes decisions based on low-level symptom/indicator/results problems. Curriculum embedded test.

Final Stage — Student decides if anything is wrong based on higher-level symptom/indicator problems. (See A. Condition above).

D. Media - Lesson booklet

E. Estimated Hours of Instruction - 2

Appendix B

Instructor Guide Lesson Description

for One Lesson in Unit VIII

UNIT VIII. DIAGNOSING EQUIPMENT MALFUNCTIONS

Lesson 3. Finding Descriptions of Symptoms: One Indicator

TERMINAL OBJECTIVE: Compares obtained result with description of symptoms including one indicator, in a trouble-shooting table in a TM.

CONDITION: Given a description of an equipment symptom including one indicator, and given a list of symptoms from a troubleshooting table.

STANDARD: Student locates the symptom description matching the equipment symptom.

ESTIMATED LESSON LENGTH: 2 hours

METHOD OF INSTRUCTION: Student Guide containing self-paced materials, exercises, and checkpoint.

OTHER MEDIA AND SUPPORT MATERIALS: Additional review exercise and checkpoint, scoring keys for checkpoints.

REFERENCES: Many TMs used in the 31M10 course include troubleshooting tables based on symptoms. Most of the material in this lesson is based on TM 11-5895-453-14-2, Table 5-11.

LESSON STRUCTURE: The lesson is divided into three sections:

Section A. Recognizing Symptoms

Section B. Reading Symptom Descriptions

Section C. Matching Equipment Symptoms to Symptom Descriptions

ENABLING OBJECTIVES:

Section A

Action: Defines the terms symptom and malfunction.

Condition: Given descriptions of results on equipment and information concerning the normal indication.

Standard: Classifies examples and non-examples of symptoms correctly.

Section B

Action: Analyzes descriptions of symptoms (one indicator) from a troubleshooting table.

Condition: Given a symptom description from a troubleshooting table.

Standard: Identifies the equipment component, operator action, and resulting symptom.

Section C

Action: Decides whether equipment symptoms match TM symptom descriptions (one indicator).

Condition: Given a description of what happened on equipment and a symptom description from a TM.

Standard: Decides whether the two descriptions match or not.

Appendix C

FBSEP Student Evaluation Checklist

Name _____ Unit _____ Lesson _____

Use the scales below to rate the lesson materials and tests. Put a check on the line to tell how you felt.

1. The lesson was:

very boring	a little boring	O.K.	a little interesting	very interesting

2. The lesson was:

very hard	sort of hard	O.K.	sort of easy	very easy

3. The lesson was:

easy to understand	sort of easy to understand	O.K.	sort of hard to understand	hard to understand

4. The lesson had:

too few exercises		just the right number of exercises		too many exercises

5. The tests and checkpoints were:

very hard	sort of hard	O.K.	sort of easy	very easy

6. The self-correcting exercises were:

very hard	sort of hard	O.K.	sort of easy	very easy

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7. What did you like best about the lessons and tests?

8. What did you <u>not</u> like about the lessons and tests?

9. Other specific comments about the test errors and additional queries.